The 1971 Western Spruce Budworm Pilot Test

Nezperce National Forest and Idaho State Lands

USDA Forest Service
Northern Region
Div. State and Private Forestry
Missoula, Montana

COVER

Budworm defoliated fir reproduction with fifth instar budworm superimposed.

THE 1971 WESTERN SPRUCE BUDWORM PILOT TEST-- NEZPERCE NATIONAL FOREST AND STATE OF IDAHO LANDS

by

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ABSTRACT

A pilot test using Zectran FS-15 was conducted against the western spruce budworm, *Choristoneura occidentalis* (Free.) on the Nezperce National Forest and State of Idaho lands during 1971. Three blocks of about 3,000 acres each were treated using the registered formulation. Budworm population reductions ranged from 28 to 68 percent 8 days after spraying, depending on area and host. Levels of parasitism increased slightly after spraying.

INTRODUCTION

Pilot testing of Zectran as a suitable substitute for DDT for suppression of the western spruce budworm, *Choristoneura occidentalis* (Free.) began in 1966. Since then such variables as dosage rates, concentrations, droplet size, and type of spray equipment have been evaluated (Taynton 1967; Honing 1968; McGregor and Dewey 1969; Anonymous 1969). Results of testing have been erratic but, in most cases, promising. By the end of 1970, sufficient testing had been completed to register Zectran for budworm control. Zectran is registered (U.S. Department of Agriculture, Registration #464-390) for control of western spruce budworm; spruce budworm, *C. fumiferana*; and jack pine budworm, *C. pinus*; at the rate of 0.15 pound in 1 gallon of oil carrier per acre. A pilot test was conducted in 1971 to accomplish the following:

1. Test the strategy of applying registered Zectran FS-15 to protect resource values on relatively small areas until natural factors suppress surrounding budworm infestations. This would be accomplished by remeasuring budworm population levels and defoliation within the spray blocks for at least 3 successive years.

2. Test the effectiveness of registered Zectran FS-15 in reducing budworm populations in mixed stands of true firs and Douglas-fir, rather than on the pure Douglas-fir stands previously tested.

1/ Entomologists, Forest Insect and Disease Branch

3. Evaluate the effect of registered Zectran FS-15 on budworm parasites.

No criteria for success was defined. The spray was applied and the results were evaluated.

This test was conducted on the Nezperce National Forest and adjoining lands administered by the Idaho Department of Public Lands.

TEST DESIGN[2/]

Sample size.--The sample size was based on data from the 1969 Zectran pilot test on the Nezperce National Forest. Estimates of the population variance components for a given sample size were obtained from the following relationships.

$$S_b^2 = MSB$$

$$S_t^2 = \frac{MST - MSB}{b}$$

$$S_a^2 = \frac{MSA - MST}{bt}$$

Where: S_b^2, and S_a^2 = branch, tree, and area variance components respectively, MSB, MST, MSA = mean square branches, trees, and areas respectively, b = number of branches/tree, t = trees/area, and

$$S_x^2 = \frac{S_b^2}{atb} + \frac{S_t^2}{at} + \frac{S_a^2}{a}$$

Where: S_x^2 is the variance of the overall mean.

These equations were solved for each treatment by species, prespray, and 4-day postspray population densities, assuming a fixed value of 3 for a, the number of areas per treatment, and varying t, the number of trees per area, and b, the number of branches per tree.

2/ The test design was prepared as a result of consultation with Dr. Donald V. Sisson, Biological Statistician, Utah State University, Logan, Utah, and Dr. Albert Stage, Intermountain Forest and Range Experiment Station, Moscow, Idaho.

The data showed that for a given number of branch samples per tree (b = 2 or 4), there is relatively little difference between a sample size of 75 trees versus 50 trees. In addition, for a given value of t (25, 50, or 75), the selection of four versus two branch samples per tree has little effect in the variance estimates. It is possible, however, that a small branch sample size (b = 2) may result in higher postspray counts than prespray counts. Since the expense of taking four branch samples versus two branch samples was not excessive, it seemed logical to take four branch samples from each tree. Therefore, sample size for the 1971 pilot project consisted of:

3 blocks per treatment.
50 sample trees of each species, Douglas-fir and grand fir, per block.
4 branch samples taken at midcrown from each tree 24 to 48 hours prior to spraying and 4 to 8 days after spraying (Ciesla et al. 1971).

The basic sample unit was four 15-inch branches taken from midcrown. Budworm population densities were expressed in terms of the number of larvae per 100 buds.

Description of test areas.--The test consisted of three spray blocks and three check blocks. The spray blocks were in North Meadow Creek (2,807 acres), Cougar Creek (3,372 acres), and Service Flats (2,073 acres). The check blocks were located on Tahoe Ridge, Cove Creek, and Free Use Ridge (Fig. 1). Blocks were established to coincide with natural boundaries, primarily ridges. Forest cover type in each block was a mixture of grand fir and Douglas-fir interspersed with nearly pure stands of ponderosa pine. Engelmann spruce and western larch occurred as minor components of the stand. All age classes were represented.

In order to meet the criteria of objectives 1 and 2, the test areas were within a large budworm infestation. This area had received significant defoliation annually since 1964. The terrain was mountainous but not rugged. Elevational differences did not exceed 1,000 feet within test units. The road network was extensive throughout the area providing excellent access.

All test blocks were within 25 air miles of Grangeville. They were located on the Nezperce National Forest with the exception of Service Flats which is administered by the Idaho Department of Public Lands.

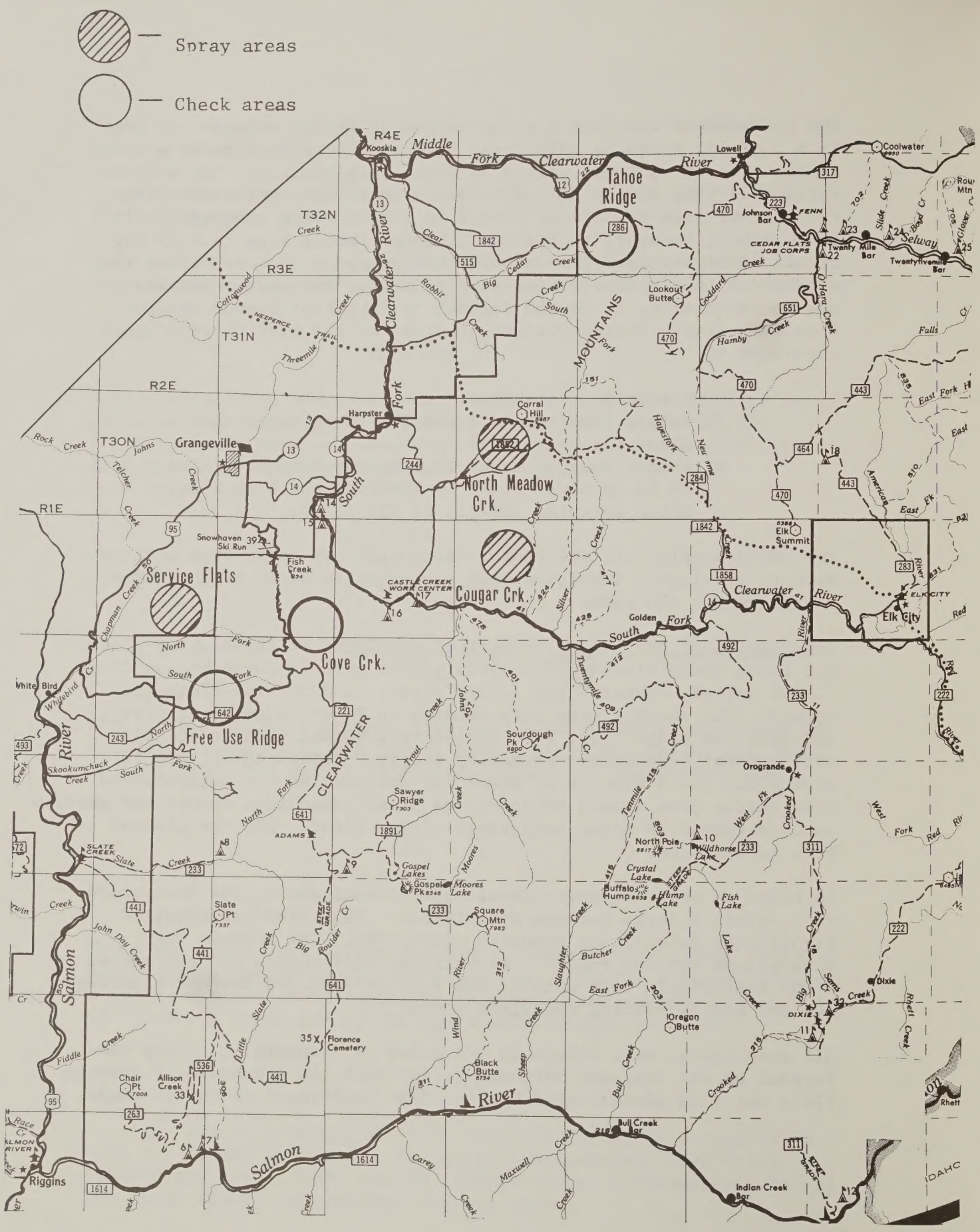


Figure 1.--Approximate location of test blocks, Zectran pilot test, 1971

Description of sample trees.--Douglas-fir and grand fir were the two species sampled. Although other species indigenous to the mixed conifer type of northern Idaho also serve as hosts for this insect, they were not sampled because they did not occur in sufficient numbers in the test areas for satisfactory analysis.

Sample trees were 30 to 50 feet tall, open grown, and not shielded by taller trees. Sample trees were selected in such a way as to provide a representative sample over each block to the extent that forest types within each block permitted.

ADMINISTRATION AND ORGANIZATION

Personnel from the Forest Insect and Disease Branch, Division of State and Private Forestry, Missoula, in cooperation with the Nezperce National Forest, administered the test. An administrative assistant was assigned to this project from the Nezperce Forest. He was responsible for purchasing necessary supplies, hiring of temporary personnel, and timekeeping. Additional personnel were detailed from Region 1, Nezperce National Forest, and other Regions to provide sufficient manpower for this test (Fig. 2). Operations began in early June.

TRANSPORTATION AND COMMUNICATIONS

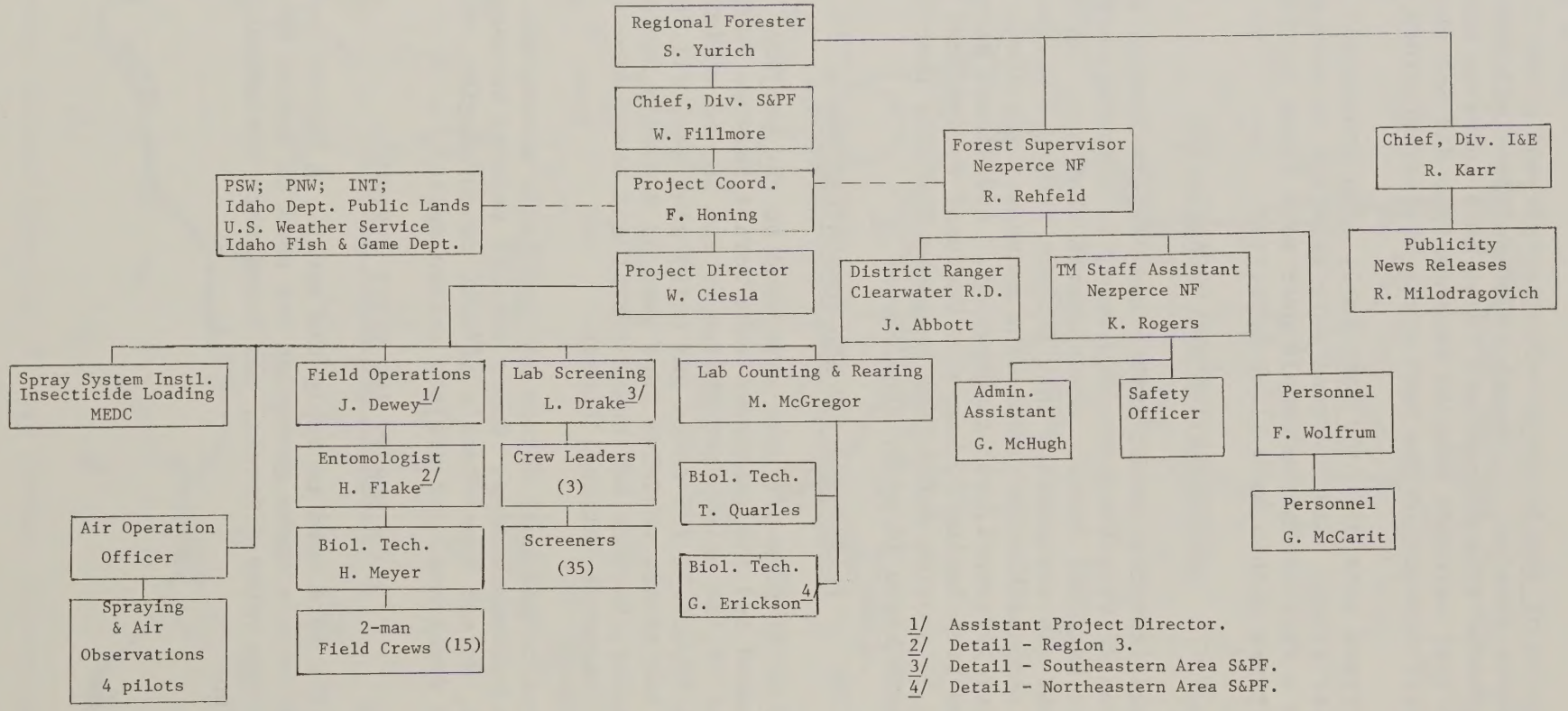
A total of 25 pickup trucks were used on the project. Twenty-two were leased and the remainder were Forest Service vehicles. A total of 29,154 miles were driven by the leased vehicles at a cost of $8,421.72 (29 cents per mile) plus gas, oil, and maintenance. Additional vehicles were used by Missoula Equipment Development Center, Pacific Northwest Forest and Range Experiment Station, and the Nezperce National Forest.

The Nezperce National Forest air net radio system was used to provide communications. Radio contact existed between the aircraft, airport, Forest Supervisor's office, meteorologist, meteorological station operators, and project entomologist.

AIRCRAFT AND SPRAY SYSTEM

Two C-47's were used to apply the spray. A Forest Service Cessna 185 equipped with a smoke generator was used to locate spray boundaries, monitor the spray aircraft, and coordinate the overall spray operation.

Figure 2.--Organization chart for 1971 pilot test for western spruce budworm Nezperce National Forest, Idaho.



1/ Assistant Project Director.
2/ Detail - Region 3.
3/ Detail - Southeastern Area S&PF.
4/ Detail - Northeastern Area S&PF.

Each spray plane was equipped with a nitrogen pressurized spray system designed by Missoula Equipment Development Center (MEDC). Boom pressure was 40 pounds per square inch. Spray booms on the two aircraft were equipped respectively with 103 and 104 - 8015 T Jet Spray System, Inc., spray tips directed downward 90° to the thrust line of the aircraft. The spray tank capacity was 700 gallons. Spraying was done at a flying speed of 150 miles per hour, releasing 152 gallons per minute. A spray droplet spectrum of 113 mass median diameter (m.m.d.) was measured on the ground (Maksymiuk et al. 1971).

SAFETY

A safety plan was prepared and adhered to (Ciesla et al. 1971). A safety officer was appointed from the Forest, and periodic safety meetings and inspections were held.

Three physicians in Grangeville were contacted and informed of the test. They were requested to have a supply of antidote on hand in the event of accidental poisoning. The names and phone numbers of all three physicians were posted conspicuously at the airport and the field laboratory.

METEOROLOGICAL INFORMATION

A meteorologist from the U. S. Weather Service was assigned to the test. He was responsible for monitoring and forecasting weather on proposed dates of spray application. Weather monitoring consisted of receiving and analyzing national weather data and collecting local meteorological data within the spray blocks (Fig. 3).

Smoke was released over the spray areas prior to spraying to indicate wind direction at different levels and identify air movement that may have influenced dispersion of spray particles. This information was used to determine optimum spray release timing and duration of each day's work. Smoke was also used to direct spray pilots over areas where spray runs were difficult to describe or accurately place on a map.

Figure 3.--Meteorologist collecting weather data.

ENTOMOLOGICAL PHASES

Development sampling.--Development sampling began June 3 and continued through June 22. Four branch samples approximately 15 inches in length were collected from midcrown of at least 10 grand fir and 10 Douglas-fir located in each area. Branches were collected with extendable pole pruners with catch bags attached to prevent budworm larvae from being lost when disturbed (Fig. 4).

Branches were placed in plastic bags and taken to the laboratory for examination. Caution had to be taken to keep samples in the shade to prevent sweating and burning inside the plastic bags. Initially areas were sampled on alternative days, but they were later sampled daily as budworm development progressed.

Trees that were established for population sampling were not disturbed during development sampling.

Figure 4.--Field crew collecting and bagging samples.

In the laboratory, each branch was examined and all larvae removed and placed in alcohol. Instars were classified by head capsule measurements and diagrams prepared by V. M. Carolin, Pacific Northwest Experiment Station. Instar determinations were made by entomologists. Daily instar development was recorded for each area (Fig. 5).

Population sampling.--Estimates of population densities of spruce budworm were obtained at three periods within each unit:

1. Prespray (within 48 hours prior to spraying).

2. First postspray (4 days after spraying).

3. Second postspray (8 days after spraying).

Figure 5.--Entomologist plotting daily instar development.

Four 15-inch midcrown branch samples were collected from each sample tree each sample period. They were treated in the field identically to the development samples. The same crew collected samples from specific sample trees each sampling period.

At the end of the field day samples were taken to a walk-in cooler for storage until they were examined in the laboratory.

Laboratory.--A modern, well-lighted, and ventilated office building was used for laboratory phases of the project. Branch samples were not stored in refrigeration longer than 48 hours prior to laboratory examination.

In the laboratory, 35 trained women under the supervision of an entomologist removed all insects from foliage and webbing with a camel-hair brush and/or forceps and placed them in Petri dishes. Sample collection tags were secured to the Petri dishes with rubber bands and shelved until they were counted and data recorded. Defoliated and nondefoliated current year's buds were counted.

An entomologist and three trained laboratory technicians separated budworm larvae from associated species. All larvae from samples were counted and prepared for parasite rearing in Petri dishes. Not more than 10 larvae were placed in each Petri dish with a 1- by 2-inch piece of artifical media (Lyon and Flake 1966).

Petri dishes containing all budworm larvae from each tree were labeled as to area, tree number, and number of larvae per dish, and shelved for parasite rearing. Parasites were submitted to specialists for identification.

AERIAL SPRAY OPERATIONS

Spray was applied on 3 consecutive days, June 22, 23, and 24. North Meadow Creek was sprayed in part on June 22. Cougar Creek and the remainder of North Meadow Creek were sprayed on June 23, and Service Flats was sprayed June 24 (Fig. 6).

Instar distribution immediately prior to spraying was as follows:

Area	Date of sample	Percent per instar			
		III	IV	V	VI
North Meadow Creek	06 20	3	55	40	2
Tahoe Ridge	06 20	6	42	48	4
Cougar Creek	06 21	6	60	33	1
Cove Creek	06 21	4	38	54	4
Service Flats	06 22	6	54	38	2
Free Use Ridge	06 22	2	42	54	2

Several problems developed during the morning of June 22. A second, unauthorized, observer aircraft was in the area and began flying close to the spray aircraft. We had no radio communication with this aircraft and consequently were unable to get him out of the area.

The No. 2 spray aircraft developed a leaky boom which sprayed the Zectran-kerosene into the exhaust system of the starboard engine. As the aircraft accelerated, the exhaust ignited the kerosene causing a momentary flash fire which burnt a hole in the fabric of the aircraft's elevator. This aircraft was grounded for the remainder of the day and the elevator section replaced later that afternoon.

Ground crews neglected to activate the nitrogen cylinders which powered the spray system on the No. 1 aircraft when it came in for a second load of spray. This resulted in an inoperable boom, half of which was open and delivering spray outside the designated test area.

Figure 6.--C-47 applying Zectran FS-15.

Acreages sprayed in the individual blocks were:

Location	Gallons prepared	Acres sprayed
North Meadow Creek	2,807 -150 (lost)	2,657
Cougar Creek	3,372	3,372
Service Flats	2,073	2,073

RESULTS

Impact on target insect.--Population sampling indicated a moderate to low budworm population in the study areas prior to spraying (Table 1).

Table 1.--Western spruce budworm population densities, prespary and postspray, Nezperce NF, 1971.

Area	Treatment	Species	Number of larvae/100 buds (± 1 SE)		
			Prespray	4-day postspray	8-day postspray
N. Meadow Cr.	Spray	GF	10.43 ± 0.85	5.52 ± 0.53	5.05 ± 0.55
		DF	13.31 ± 1.48	5.66 ± 0.89	4.45 ± 0.54
Cougar Creek	Spray	GF	4.30 ± 0.41	2.13 ± 0.31	1.33 ± 0.16
		DF	3.71 ± 0.52	2.28 ± 0.31	2.06 ± 0.27
Service Flats	Spray	GF	4.32 ± 0.33	2.83 ± 0.25	1.90 ± 0.26
		DF	6.21 ± 0.83	3.96 ± 0.46	2.56 ± 0.46
Tahoe Ridge	Check	GF	13.35 ± 1.42	14.44 ± 1.55	13.99 ± 1.59
		DF	14.16 ± 1.71	17.31 ± 1.72	15.16 ± 1.77
Cove Creek	Check	GF	5.28 ± 0.47	5.04 ± 0.46	3.76 ± 0.34
		DF	4.04 ± 0.39	3.93 ± 0.53	3.15 ± 0.32
Free Use Road	Check	GF	7.55 ± 0.79	7.46 ± 0.82	5.86 ± 0.63
		DF	9.47 ± 0.92	8.51 ± 0.72	7.48 ± 0.58

Population reduction in the treatment blocks was relatively low and quite variable (Tables 2 and 3). Differences between treatment and checks are statistically significant at the 99 percent level. There was no significant differences between tree species.

Table 2.--Four- and 8-day postspray survival ratios Zectran pilot project, Nezperce NF, 1971.

Area	Treatment	Species	Survival ratio (95% confidence limit) 4-day	8-day
N. Meadow Cr.	Spray	GF	0.5292 ± 0.138	0.4846 ± 0.135
		DF	0.4251 ± 0.137	0.3346 ± 0.128
Cougar Cr.	Spray	GF	0.4947 ± 0.137	0.3098 ± 0.128
		DF	0.6154 ± 0.135	0.5563 ± 0.138
Service Flats	Spray	GF	0.6563 ± 0.132	0.4394 ± 0.137
		DF	0.6383 ± 0.133	0.4124 ± 0.136
Tahoe Ridge	Check	GF	1.0819	1.0482
		DF	1.2224	1.07
Cove Creek	Check	GF	0.9505 ± 0.050	0.7097 ± 0.126
		DF	0.9750 ± 0.043	0.7813 ± 0.114
Free Use Rd.	Check	GF	0.9881 ± 0.030	0.7771 ± 0.115
		DF	0.8985 ± 0.083	0.7897 ± 0.114

Table 3.--Corrected percent mortality, western spruce budworm pilot test, Nezperce National Forest.

Area	Species	Corrected percent mortality due to Zectran[1/] 4-day	8-day
N. Meadow Cr.	GF	51.09	53.77
	DF	65.22	68.08
Cougar Creek	GF	47.96	43.41
	DF	36.89	28.42
Service Flats	GF	33.58	43.46
	DF	28.96	47.78

1/ Corrected percent mortality derived as follows:

$$100\ (1.0 - \frac{\text{survival treated}}{\text{survival control}})$$

Impact on parasites.--The primary parasites recovered were *Glypta fumiferanae* (Vier.) and *Apanteles fumiferanae* Vier. (Table 4).

Table 4.--Percent parasitism for all spray areas.

Parasite	Prespray	4-day postspray	8-day postspray
A. fumiferanae	3.63	3.70	6.65
G. fumiferanae	2.55	2.81	2.96
Tachinids	1.56	2.46	2.76
Others	0.16	0.48	0.15
Total	7.91	9.46	12.52

Analysis of variance showed no significant different in percent parasitism at the 0.05 level between prespray and first postspray samples or between the first and second postspray samples. A

significant difference in percent parasitism at the 0.05 level was found between the prespray and second postspray sample. Overall parasitism averaged 8.48 percent on Douglas-fir and 11.45 percent on grand fir. Parasitism by *Apanteles* sp. showed a significant increase between the prespray and second postspray sample. Parasitism by *Glypta* sp. and tachinids did not increase appreciably.

Total parasitism was significantly different between spray areas and check areas.

Parasitism remained essentially unchanged from the prespray to the postspray sample in the check areas for all parasite species sampled (Table 5).

Table 5.--Percent parasitism by species in check blocks.

Parasites	Collection period	
	Prespray	4-day postspray
Apanteles	1.920	1.730
Glypta	1.910	1.380
Tachinids	4.860	4.650
Other parasites	.161	.231
Total	8.851	7.991

DISCUSSION

The budworm reduction values for the test were disappointingly low. Climatic conditions during spraying appeared good and, for the most part, the areas were well flown. Indications are mortality was low because of lack of uniform insecticide coverage on the ground. In a test to measure spray deposit using fluorescent tracers in the Service Flats area, Maksymiuk, et al. (1971), found a wide variation in the deposit coverage both within and between individual trees. They also found a very good correlation between budworm mortality and amount of spray deposit. It was shown that a deposit of 5 ug Zectran/75 needles was needed to obtain a budworm population reduction exceeding 70 percent. Of the 96 trees in Service Flats that were measured for deposit, only 15 had 5+ ug Zectran/75 needles; 34 had 1.0 to 5.0 ug/75 needles; and 48 had .01 to 1.0 ug/75 needles.

From the spray deposit assessment data, it appears that getting the spray to the ground is still a problem. The measured droplet size at ground level was 113.7 microns m.m.d. (Maksymiuk et al. 1971). Although this is in the general category of medium atomization, perhaps it is still too small a droplet to apply operationally in forested, mountainous terrain. The droplet size spectra used on DDT projects were between 150 to 300 microns m.m.d. (McComb 1956; Anonymous 1960). Budworm populations were invariably reduced by 90+ percent on those projects, indicating the material was reaching the target. Though it has been shown that small droplets are more effective in killing spruce budworm (Himel and Moore 1967), it may be necessary to continue to use larger droplets until a means of getting smaller droplets to the target insect is developed.

Other factors that may have influenced mortality include:

1. The new foliage in all areas was very profuse, probably due to a wet spring and light defoliation. This provided good protection for the larvae during spraying (Fig. 7). It appeared that 1971 shoot growth was appreciably greater than normal; however, shoot measurements failed to substantiate this.

Figure 7.--Budworm larva concealed by foliage.

2. Budworm development. Though development was within the established guidelines (90 percent fourth and fifth instars) on spray days, the majority of larvae were appreciably smaller than on previous tests. Spray day development in 1968 averaged 15 percent third and fourth instars and 85 percent fifth and sixth; in 1969 it averaged 22 percent third and fourth instars and 78 percent fifth and sixth; in 1971 development averaged 62 percent third and fourth instars and only 38 percent fifth and sixth. This made the target smaller, less active and it was concealed because foliage had not been consumed.

As a result of this test it is apparent that Zectran is not ready for operational use against the western spruce budworm in the western United States.

Additional testing is necessary to provide additional information on optimum spray droplet size, optimum larval development, size of spray blocks that can be effectively protected, and cost-benefit ratio of spraying.

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